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THE EFFECT OF HUMAN WORKING CAPACITY AT HIGH TEMPERATURES ON THE DEVELOPMENT OF INDUSTRIES IN TROPICAL AND SUBTROPICAL AREAS

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THE EFFECT OF HUMAN WORKING CAPACITY AT HIGH TEMPERATURES ON THE DEVELOPMENT OF INDUSTRIES IN TROPICAL AND SUBTROPICAL AREAS

In establishing industries in areas of the tropical rain belt, observations have been made that the attained rate of work is by far inferior to that considered as normal in the temperate zones. Equal technical facilities provided, a considerable higher number of workers is required to attain an equal output. Though this point has not yet become a critical factor economically, since in these areas wages are still much lower than in the temperate zones, it must be borne in mind that in the tropical zones, too, an increase in wages is inevitable. This means, however, that these industries in tropical and subtropical areas which often work already on the verge of yield would no longer be competitive. Thus, the problem of an increased output per man is of decisive importance to the future development of industries in tropical zones.

The reasons for the inferior output are supposed to be psychological and sociological ones. The importance of these factors is obvious and shall not be denied; rather should the question be examined to which physical factors of heat tolerance these psychological and sociological phenomena are due.

The development of these phenomena which are known as "tropical fatigue" are particularly evident in the Europeans transferred from a temperate climate to work in a tropical zone. It has often been observed that in the beginning of their living in the tropics the Europeans still maintain a relatively high physical and mental working capacity. But already in the second year we notice a reduced physical capacity, often accompagnied by a marked disinclination to any type of work. After a lapse of - say - three years the development, which, of course, may be accelerated by an unhealthy mode of living, alcoholic excesses etc., has reached a point where a leave for Europe is indicated which promptly results in an improvement of physical and mental fitness.

Recent investigations have proved that the differences in heat regulation between the native, mostly coloured inhabitants of the tropical zones and the members of the white race, which formerly were taken for granted, are but very slight. We may assume that the native, and the coloured native too, is subjected to climatic influences in the same way as the European is, in whom these influences cause a reduced working capacity after a few years. The only difference is that in persons born and grown up in the tropical zones these symptoms proceed less obviously than in the immigrated European but become stationary on a level which depends on the climatic conditions and on the mode of living of the person concerned.

If this assumption is correct, it may be concluded that the working capacity level of persons born and grown up in tropical areas is lower than that of most European workers, independent of the race they belong to. Investigations on this problem have only been possible since we dispose of standardized methods for the measurement and quantitative comparison of the working capacity. Investigations conducted by MEYER-DELIUS on Venezuelan soldiers, who may be considered as a positive selection from the native inhabitants, showed a considerably lower working capacity level than corresponding measurements in Germany. This should corroborate the assumption that growing up in tropical zones does not automatically involve an adaptation to a hot climate.

As to the possibility of acquiring an adaptation to work under heat exposure, experiences are available from various industries in temperate zones and from those nations in temperate zones which had to send troops to fight in the tropics. These experiences show that an extensive adaptation to living and working conditions in a warm climate is possible. The working capacity under heat conditions, which is but limited at the beginning, may be improved by a systematical physical training. This adaptation to a high physical load in a hot climate becomes evident in a slow increase of the pulse frequency in trained persons, whilst in untrained persons the pulse frequency rises rapidly. The same applies to the body temperature and various other functions.

It is typical for the worker living in a temperate zone but working under heat conditions that he produces far more sweat when exposed to heat during his work than the non-acclimatized worker. Since the evaporation of sweat is an important means of releasing surplus heat from the body, this phenomenon should be considered as an essential point in heat adaptation. At the same time, we observe changes in the composition of sweat and body tissue, above all a reduction of the fat and water contents.

In people so far not exposed to heat the first symptoms of adaptation may be observed a relatively short time after they have experienced a change in climate. This first stage of adaptation takes about 10 to 14 days and results in a considerable increase of the working capacity under heat conditions. Later the curve of the adaptation increases more slowly and reaches asymptotically, after about 9 to 12 months, a final level.

It seems to apply to all adaptation symptoms in the body that they develop far more rapidly and strongly if the organism is exposed to a heavy load. Thus, for instance, muscular growth and, consequently, higher muscular power cannot be effected through low exertions of a long duration but only through short exertions at maximum force. Since physical activity always goes along with an increased heat production, an adaptation of the organism to a high physical load means, at the same time, an adaptation of the body to an increased heat load.

Recent investigations have shown that the body becomes the more rapidly adapted to work and heat exposure the higher the heat load and the physical load are to which the person is subjected in the training period, precaution always provided. It is typical, however, that the adaptation to both heavy work and heat is lost again rather quickly unless the state of adaptation is systematically preserved through sufficient physical work and training. This, however, is just the thing which the inhabitant of tropical zones, immaterial whether he is born there or has immigrated, is afraid of and which he tends to avoid. He behaves like this because an excessive heat production in his body is not only disagreeable but even dangerous for him, the hot climate impeding the heat release. This is not the case in the temperate zone where people may at any time seek cool places to reduce their body temperature in case an interruption of the work should not be sufficient.

If these considerations are correct, it ought to be possible to stop the decrease of working capacity in persons living in tropical areas and to raise their physical efficiency by creating climatic conditions which guarantee a subsequent heat release after short maximum exertions under heat conditions.

Possibilities for such an arrangement are far better than they were a few decades ago. So far, air conditioning in tropical zones is mainly installed in offices and conference rooms, but only very few workshops are provided with these facilities. A full conditioning of working areas is only possible in case of some processing industries. An air conditioning of workshops would only provide the advantage to work in a cooler environment but would not increase the working capacity. For this a temporary maximum stress is necessary. In case the work itself requires such a high muscular exertion, there is no need to climatize the workshops, which would be rather difficult anyway, but only to provide rooms in which the worker could cool down during the work pauses. For persons whose work involves only little muscular exercise, possibilities should be provided where they may engage in sports and games and cool down afterwards. Investigations in practice which we are planning in Venezuela are to show in how far these measures will contribute to an increase of working capacity.

An improvement of the physical working capacity always goes along with an increase of personal well being and readiness to work. Therefore, it is hoped that the results of the measures described will not be limited to the physical conditions but will also have a favourable influence on the psychological attitude of the worker and improve the psychological and sociological state in the tropical zones. It speaks in favour of these reflections that symptoms of physical and psychic decline are frequent in the hot and humid climate of the tropical rain belt but are rare in the desert climate where the dry air alleviates the heat release from the body and which is, furthermore, characterised by an abrupt change of temperature at night and in the course of the seasons.

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